Key Estimation

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Outline

- What is Key Estimation?
- Probe Tone Experiments
- Markov Models of Melodic Expectation
- Key Estimation Methods
  - Krumhansl
  - Temperley (Hidden Markov Models)

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- Identify the **tonality** of a piece of music (**key signature**)
  - In practice: Identify the tonality from MIDI-like note information (MIDI pitch, onset, duration)
- This is a useful first step for automatic harmonic analysis, automatic pitch spelling, etc.

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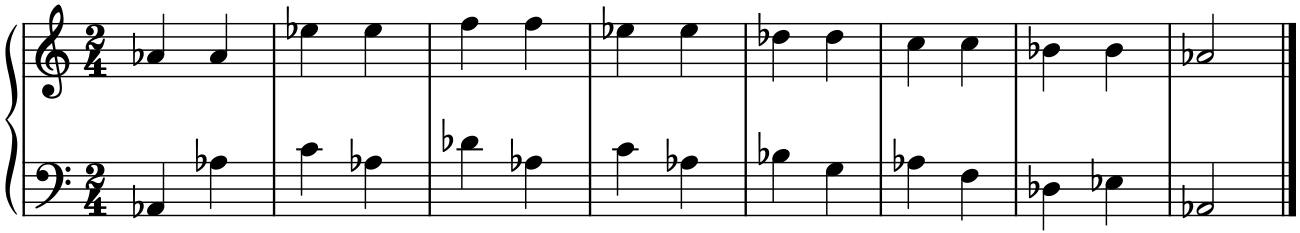

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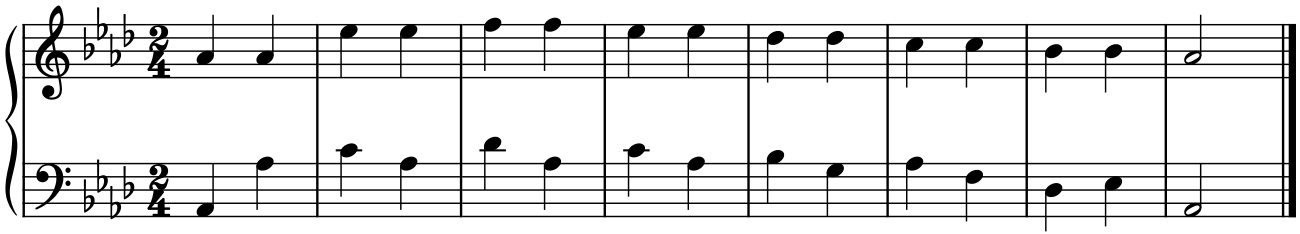

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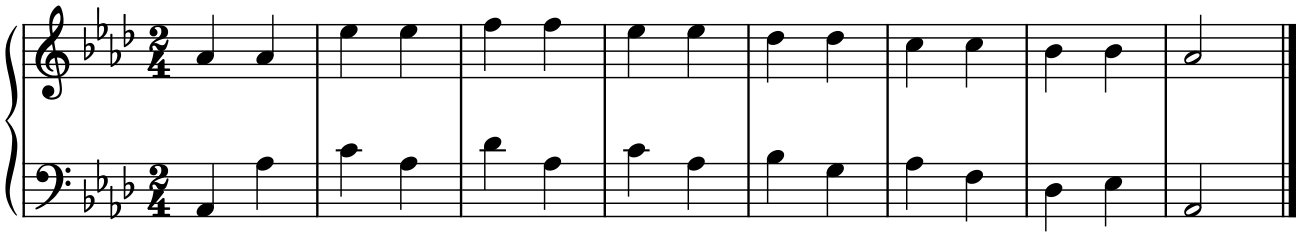

Common Key Identification Methods

- Krumhansl and Schmuckler (Krumhansl, 1990)
  - Compare pitch distribution to expected probe-tone profiles
- Chew's Spiral Array (Chuan and Chew, 2005)
  - Compare geometry of the notes in the spiral array (a 3D extension of the circle of fifths)
- Temperley's Probabilistic Approach (Temperley, 2007)
  - With hidden Markov models!

Quick Recap: Probability

- Probability: measure of the **likelihood** of an event
  - $0 \leq p(x) \leq 1$, where 0 indicates that the event is very unlikely to occur and 1 indicates that the event will most likely occur
- Random variables: X can take values x
  - For discrete variables (X can take values $x_1, \ldots, x_N$): $\sum_{x_i}^{N} p(x_i) = 1$
  - For continuous variables $\int_{-\infty}^{\infty} p(x)dx = 1$
- Probability density and mass functions
  - For continues variables, the probability that x will lie in an interval (a, b) is
    - $p(x \in (a, b)) = \int_{a}^{b} p(x)dx$
- Fundamental rules
  - Sum rule: $p(X) = \sum_{Y} p(X, Y)$
  - product rule: $p(X, Y) = P(Y \mid X)P(X)$
    - If X and Y are independent: $P(X, Y) = P(X)P(Y)$
  - symmetry: $P(X, Y) = p(Y, X)$
- Bayes' Theorem
  - $p(Y \mid X) = \frac{p(X \mid Y)p(Y)}{p(X)}$